Orion Power Needs

By

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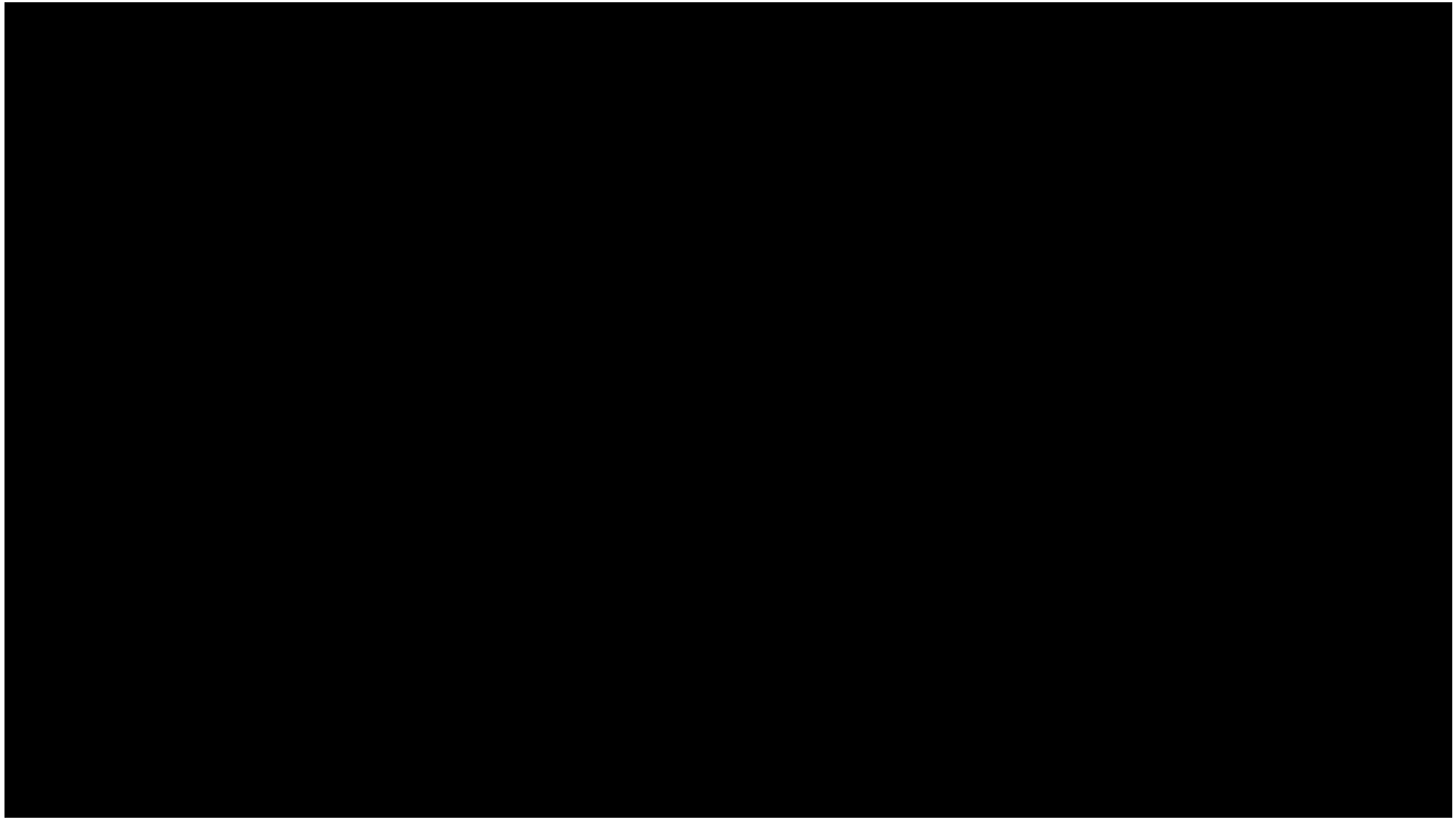


Orion Overview

Engineering Flight Test (EFT) 1

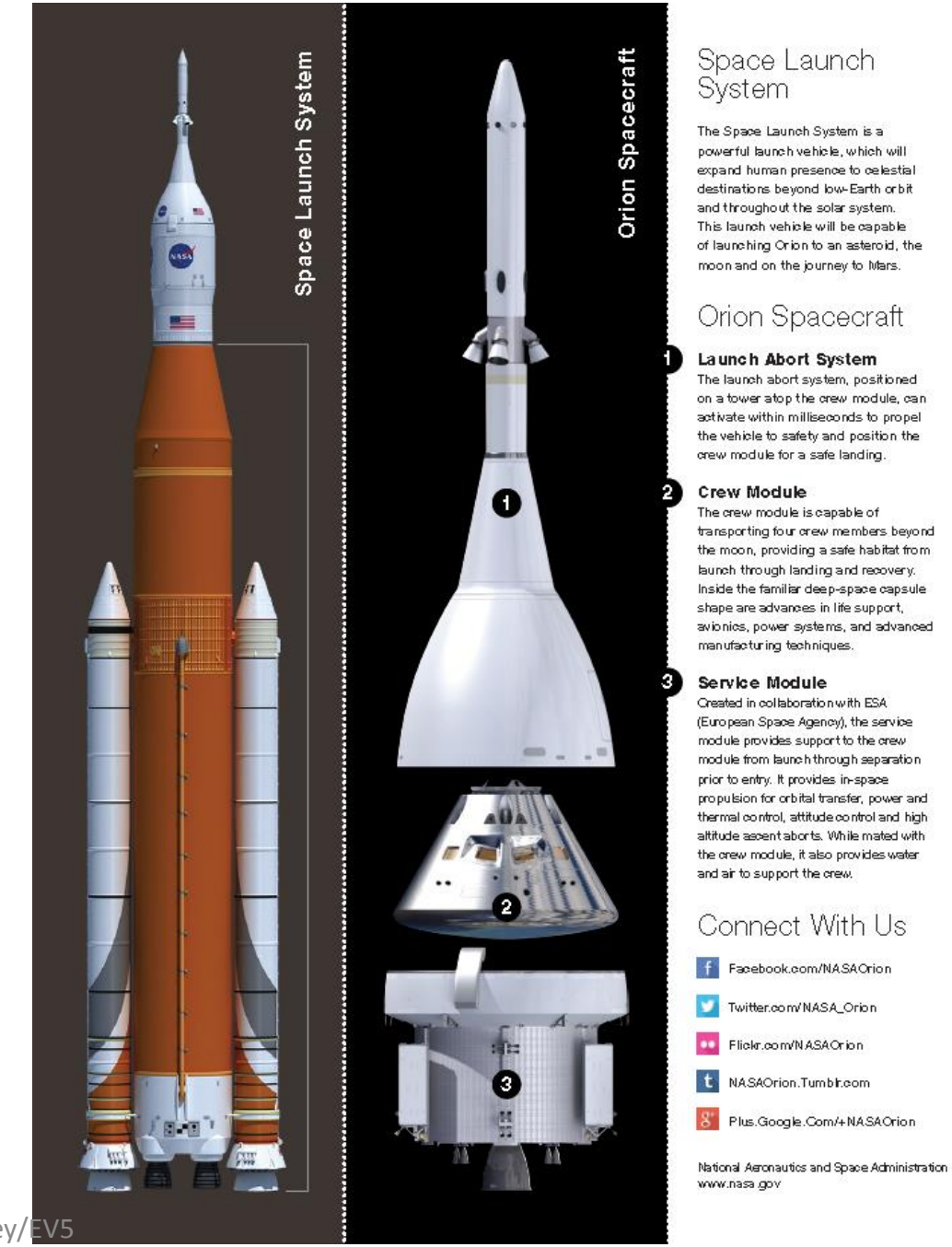
- Duration: 4 hours, 24 min
- Test flight
- 2014

EM1

- Duration: 26-40 days
- Crewed configuration but with no crew
- Orbit the moon and return
- Scheduled for 2019

EM2

- Duration: 8-21 days
- Crewed mission doing a lunar flyby
- Scheduled for 2023



Power and Radiation Reqt's on Orion

- 120VDC system
  - MOSFET must have SOA of 182VDC for the 120V (136VDC worse case) application
  - For another application on Orion, an SOA of up to 248VDC was required
- Radiation requirements for MOSFETs for Orion is:
  - 1E7 ions/cm2 at LET=75 without destructive failure or damage
  - Tested with a sufficiently penetrating ion to ensure the epitaxial region is stimulated.
- Most were tested in the flight configuration
- Variations to the test requirements had to be approved by the Orion Ionizing Radiation Working Group (IRWG) comprised of Lockheed Martin and NASA Radiation effects engineers and including representatives of the other partners as needed.

PDU

- The Power Distribution Unit (PDU) distributes power in the crew module.
- For the PDU application, a very small package size was required along with a low Rds-on due to size constraints.
  - Available commercially available radiation tolerant parts could not meet the size constraint.
  - SiC was a good candidate for this application and the team searched for a potential part.
- The CREE SiC MOSFET was chosen for use on Orion in the PDU
  - Initially, CREE only made the die and they were packaged elsewhere
  - Over time, CREE made commercial high voltage, low Rds-on SiC MOSFETs (50A and 80A) as a part of their commercial product line

CREE SiC MOSFET test results

- The CREE MOSFET survived the radiation testing without destruction but there was damage to the gate caused by the radiation.
  - The gate had leakage which increased with fluence.
  - The system designers determined the leakage was acceptable for the PDCU application after radiation testing.
- The team set off to determine of the gate leakage could be increased by other mechanisms.
  - Burn-in testing – no effect
  - Proton testing – displacement damage/dose – no effect
  - Dose testing – no effect
- It was postulated by the team that the ions were damaging the gate material.
- CREE SiC MOSFETs were Radiation Lot Acceptance Tested (RLAT)

SiC on Orion and in the future

- On an EM-1 or EM-2 mission there would be no measureable radiation damage to the CREE MOSFET gate due to the limited flight time.
- Orion missions are very short compared to other deep space missions within the agency. The gate leakage issue would have to be evaluated by the system designers for acceptability or designed out before use in those longer missions.
- SiC is an exciting possibility for the future of space flight across the agency providing a small package and low Rds-on